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Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2005

Appendix A: Database Details and Calculation Methods

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Appendix A

Estimated vs Final Fuel Economy

Table A-1 compares average 55/45 laboratory fuel economy for model years 1998 through 2003 at three points in time:

(1) an initial estimate determined early in each model year using just projected sales,

(2) a revised estimate determined by using trade publication sales data that were obtained after the end of each model year, but before the data used for the CAFÉ calculations were submitted to the Federal Government, and

(3) final fuel economy values determined from compliance data provided by the manufacturers to the Federal Government after the end of the model year.

The next report in this series will provide updated data for model years 2004 and 2005 based on information available at that time.

Table A-1

Comparison of Laboratory 55/45 MPG

	Model Year	Initial Estimate	Revised Estimate	Final Value
Cars	1998	28.6	28.6	28.5
	1999	28.1	28.2	28.1
	2000	28.1	28.3	28.2
	2001	28.3	28.3	28.4
	2002	28.5	28.5	28.6
	2003	29.0	28.9	28.9
Trucks	1998	20.6	20.6	20.9
	1999	20.3	20.4	20.5
	2000	20.5	20.5	20.8
	2001	20.3	20.4	20.6
	2002	20.4	20.3	20.6
	2003	20.8	20.9	20.9
Both	1998	24.4	24.4	24.5
	1999	23.8	24.0	24.1
	2000	24.0	23.9	24.3
	2001	23.9	24.0	24.2
	2002	24.0	23.9	24.1
	2003	24.4	24.2	24.3

Appendix A

Averaging Fuel Economy Values

Dimensionally, fuel economy is miles divided by gallons. Then, presented with more than one fuel economy value, an approach to averaging the values is to compute the result by determining the total miles traveled and dividing that by the total gallons used.

Example: A motorist's fuel economy log for May shows that 704 miles were accumulated around town in which the fuel economy was 16 mpg, and one 216 mile trip was taken on which the fuel economy was 24 mpg. What is the average fuel economy for May?

The total miles are 704 + 216 = 920. The total gallons thus, are 704 / 16 = 44 plus 216 / 24 = 9; 53 gallons. The average mpg is 920 / 53 = 17.4 mpg. Notice that the arithmetic average of the two fuel economy values (16 + 24) / 2 = 20 mpg gives an individual result which is higher than the total miles/total gallons result.

Even if the around-town miles traveled and the trip-miles traveled were the same (460 miles), the average fuel economy would not be 20; it would be 19.2 mpg. This is because in the total miles/total gallons approach, *fuel consumption* is arithmetically averaged, but *fuel economy* is harmonically averaged, so for the second example (equal trip distances), the calculation would be:

Average MPG = 2 / (1/16 + 1/24) = 19.2 MPG,

which is the same as arithmetically averaging the two fuel consumption values.

A specific example of this type of averaging approach is shown in the calculation of the overall average fuel economy using the EPA "city" (MPG_C) and EPA "highway" (MPG_H) fuel economy values.

$$\text{Average MPG} = \frac{\text{Total Miles}}{\text{Total Gallons}}$$

$$= \frac{\text{Total Miles}}{\text{City Gallons + Highway Gallons}}$$

$$= \frac{\text{Total Miles}}{\text{City Miles/City MPG + Highway Miles/Highway MPG}}$$

Now, if city miles are 55 percent of total miles and highway miles are the remaining 45 percent, after dividing by total miles,

$$\text{Average MPG} = \frac{1}{(.55/\text{MPG}_C) + (.45/\text{MPG}_H)}$$

and this average mpg is called the EPA 55/45 MPG value.

The same approach can be used when the average mpg of a group of vehicles with different mpg values is to be calculated. Suppose a fleet of 100,000 vehicles is made up of two classes, one of 70,000 vehicles whose fuel economy is 10 mpg and the other of 30,000 vehicles whose fuel economy is 14 mpg. Each vehicle in the fleet is assumed to travel the same number of miles (**M**),

$$\text{Total Miles} = 100{,}000\ \mathbf{M}$$

$$\text{Total Gallons} = 70{,}000\ \mathbf{M} / 10 + 30{,}000\ \mathbf{M} / 14$$

and the average fuel economy is:

$$\text{Average Fuel Economy} = \frac{1}{.7/10 + .3/14}$$

$$= 10.9 \text{ mpg}$$

where .7 and .3 are the relative shares of each vehicle class in the fleet. Notice that, again, the arithmetic average of the class fuel economy values (10 + 14)/2 = 12 mpg is higher.

In general, some form of a weighted harmonic mean is used when averaging different fuel economy values.

Appendix A

Table A-2, compares CAFE data reported by the The National Highway Traffic Safety Administration (NHTSA) with the adjusted and laboratory fuel economy data in this report. The NHTSA values are higher than the values used in the report by a few tenths of an mpg due to test procedure adjustment factors and alternative fuel credits. The NHTSA data in this table for MY1979 Trucks is just for vehicles with less than 6000 pound GVW. The EPA data in the table is final through MY2003, but preliminary for MY2004 and MY2005.

Table A-2

EPA Adjusted, Laboratory, and NHTSA CAFE Fuel Economy Values by Model Year

	Cars				Trucks				Both Cars and Trucks			
Model Year	EPA Adj.	EPA Unadj.	NHTSA (CAFE)	Diff.	EPA Adj.	EPA Unadj.	NHTSA (CAFE)	Diff.	EPA Adj.	EPA Unadj.	NHTSA (CAFÉ)	Diff.
1975	13.5	15.8	n/a		11.6	13.7	n/a		13.1	15.3	n/a	
1976	14.9	17.5	n/a		12.2	14.4	n/a		14.2	16.7	n/a	
1977	15.6	18.3	n/a		13.3	15.6	n/a		15.1	17.7	n/a	
1978	16.9	19.9	19.9	0.0	12.9	15.2	n/a		15.8	18.6	n/a	
1979	17.2	20.3	20.3	0.0	12.5	14.7	18.2		15.9	18.7	20.1	
1980	20.0	23.5	24.3	0.8	15.8	18.6	18.5	-0.1	19.2	22.5	23.1	0.6
1981	21.4	25.1	25.9	0.8	17.1	20.1	20.1	0.0	20.5	24.1	24.6	0.5
1982	22.2	26.0	26.6	0.6	17.4	20.5	20.5	0.0	21.1	24.7	25.1	0.4
1983	22.1	25.9	26.4	0.5	17.8	20.9	20.7	-0.2	21.0	24.6	24.8	0.2
1984	22.4	26.3	26.9	0.6	17.4	20.5	20.6	0.1	21.0	24.6	25.0	0.4
1985	23.0	27.0	27.6	0.6	17.5	20.6	20.7	0.1	21.3	25.0	25.4	0.4
1986	23.8	27.9	28.2	0.3	18.3	21.4	21.5	0.1	21.9	25.7	25.9	0.2
1987	24.0	28.1	28.5	0.4	18.4	21.6	21.7	0.1	22.1	25.9	26.2	0.3
1988	24.4	28.6	28.8	0.2	18.1	21.2	21.3	0.1	22.1	25.9	26.0	0.1
1989	24.0	28.1	28.4	0.3	17.8	20.9	21.0	0.1	21.7	25.4	25.6	0.2
1990	23.7	27.8	28.0	0.2	17.7	20.7	20.8	0.1	21.5	25.2	25.4	0.2
1991	23.9	28.0	28.4	0.4	18.1	21.3	21.3	0.0	21.7	25.4	25.6	0.2
1992	23.6	27.6	27.9	0.3	17.8	20.8	20.8	0.0	21.3	24.9	25.1	0.2
1993	24.1	28.2	28.4	0.2	17.9	21.0	21.0	0.0	21.4	25.1	25.2	0.1
1994	24.0	28.1	28.3	0.2	17.7	20.8	20.8	0.0	21.0	24.6	24.7	0.1
1995	24.2	28.3	28.6	0.3	17.5	20.5	20.5	0.0	21.1	24.7	24.9	0.2
1996	24.2	28.3	28.5	0.2	17.8	20.8	20.8	0.0	21.2	24.8	24.9	0.1
1997	24.3	28.4	28.7	0.3	17.6	20.6	20.6	0.0	20.9	24.5	24.6	0.1
1998	24.4	28.5	28.8	0.3	17.8	20.9	21.1	0.2	20.9	24.5	24.7	0.2
1999	24.1	28.2	28.3	0.2	17.5	20.5	20.9	0.4	20.6	24.1	24.5	0.4
2000	24.1	28.2	28.5	0.3	17.7	20.8	21.3	0.3	20.7	24.3	24.8	0.5
2001	24.3	28.4	28.8	0.4	17.6	20.6	20.9	0.3	20.7	24.2	24.4	0.5
2002	24.5	28.6	28.9	0.3	17.6	20.6	21.3	0.7	20.6	24.1	24.6	0.5
2003	24.7	28.9			17.8	20.9			20.8	24.3		
2004	24.7	28.9			17.9	20.9			20.8	24.4		
2005	24.7	28.8			18.2	21.3			21.0	24.6		

Appendix A

Use of 3-Year Moving Averages

Use of the three-year moving averages, which effectively smooth the trends, results in an improvement in discerning real trends from what might be relatively small year-to-year variations in the data. For this report, as shown in Table A-3 these three-year moving averages are tabulated at their midpoint. For example, the midpoint for model years 2002, 2003, and 2004 is MY2003.

Table A-3

Light-Duty Vehicle Laboratory Fuel Economy and Truck Sales Fraction

	Actual Data				Three-Year Moving Average			
	55/45 Fuel Economy			Truck	55/45 Fuel Economy			Truck
Year	Cars	Trucks	Both	Sales Fraction	Cars	Trucks	Both	Sales Fraction
1975	15.8	13.7	15.3	.194	****	****	****	****
1976	17.5	14.4	16.7	.212	17.1	14.5	16.5	.202
1977	18.3	15.6	17.7	.200	18.5	15.1	17.6	.213
1978	19.9	15.2	18.6	.227	19.4	15.2	18.3	.216
1979	20.3	14.7	18.7	.222	21.1	16.0	19.8	.205
1980	23.5	18.6	22.5	.165	22.8	17.5	21.5	.187
1981	25.1	20.1	24.1	.173	24.8	19.7	23.7	.178
1982	26.0	20.5	24.7	.197	25.7	20.5	24.5	.197
1983	25.9	20.9	24.6	.223	26.1	20.6	24.6	.219
1984	26.3	20.5	24.6	.239	26.4	20.6	24.7	.239
1985	27.0	20.6	25.0	.254	27.0	20.8	25.1	.258
1986	27.9	21.4	25.7	.283	27.6	21.2	25.5	.272
1987	28.1	21.6	25.9	.278	28.2	21.4	25.8	.286
1988	28.6	21.2	25.9	.298	28.3	21.2	25.8	.294
1989	28.1	20.9	25.4	.307	28.2	20.9	25.5	.302
1990	27.8	20.7	25.2	.302	28.0	21.0	25.3	.310
1991	28.0	21.3	25.4	.322	27.8	20.9	25.2	.319
1992	27.6	20.8	24.9	.334	27.9	21.0	25.1	.339
1993	28.2	21.0	25.1	.360	28.0	20.8	24.8	.366
1994	28.1	20.8	24.6	.404	28.2	20.7	24.8	.381
1995	28.3	20.5	24.7	.380	28.2	20.7	24.7	.395
1996	28.3	20.8	24.8	.400	28.3	20.7	24.7	.401
1997	28.4	20.6	24.5	.424	28.4	20.8	24.6	.424
1998	28.5	20.9	24.5	.449	28.4	20.7	24.4	.441
1999	28.2	20.5	24.1	.449	28.3	20.7	24.3	.449
2000	28.2	20.8	24.3	.449	28.3	20.6	24.2	.453
2001	28.4	20.6	24.2	.461	28.4	20.6	24.2	.465
2002	28.6	20.6	24.1	.485	28.7	20.7	24.2	.481
2003	28.9	20.9	24.3	.496	28.8	20.8	24.3	.490
2004	28.9	20.9	24.4	.488	28.9	21.1	24.4	.494
2005	28.9	21.3	24.6	.498	****	****	****	****

Appendix A

Table A-4

Vehicle Classification Exceptions

Group/Manufacturer/Vehicles		Years	Are Classified As:
DC:	Chrysler Colt 4WD Wagon	All	Small Wagon
DC:	Chrysler Colt Vista	All	Small Van
DC:	Chrysler Pacifica	All	Large Wagon
DC:	Chrysler PT Cruiser	All	Small Wagon
DC:	Chrysler PT Cruiser Convertible	All	Subcompact
DC:	Chrysler Summit Wagon	All	Small Van
DC:	Dodge Ramcharger	All	Car
DC:	Dodge Magnum	All	Midsize Wagon
DC:	Eagle 4WD Wagon	All	Car
DC:	Mitsubishi Expo	All	Small Van
DC:	Mitsubishi Space Wagon	All	Small Van
Ford:	Ford Pinto Van	All	Car
Ford:	Volvo V70 XC	All	Midsize Wagon
GM:	Isuzu Oasis	All	Midsize Van
GM:	Pontiac Vibe	All	Small Wagon
GM:	Subaru 4WD Sedans/Wagons	All	Cars
GM:	Subaru Forester	All	Small SUV
GM:	Subaru Baja	All	Small Pickup
GM:	Suzuki X-90	All	Small SUV
Toyota:	Lexus RX300	All	Midsize SUV
Toyota:	Matrix	All	Small Wagon
VW:	Audi Allroad	All	Midsize Wagon

Note: The classification of a vehicle for this report is based on the author’s engineering judgment and is not a replacement for definitions used in implementing automotive standards legislation.